



Final Evaluation Report

submitted by Bernadette Chi, PhD and Jenny Han, MS
December 2023

This report is based upon work supported by the National Science Foundation Grant #1911527).

Introduction and Background

As described in the NSF proposal, the goals of the GEODES program are to (1) improve retention of students entering the major and during and after the transition from lower-division to upper-division coursework, (2) prepare students to be competitive in the transition from UCSC to graduate school and/or the geoscience workforce, and (3) create a community and support system that will ensure a positive and productive experience of a more diverse group of students in the Earth and Planetary Sciences (EPS) department. Outcomes of this program focus on reducing disparities in graduation rate, course success, and overall GPA among EPS underrepresented minority (UM) undergraduates and increase the preparation and transfer of primarily Hispanic/Latino students to graduate school and/or the geoscience workforce.

Despite the significant challenges of COVID and the move to remote learning during the grant period, much of the GEODES program was successfully implemented to support students in the UC Santa Cruz Earth and Planetary Sciences department, including the program mentors and GEOSlug Lounge during the first year of the grant prior to remote learning and the GEOAce courses and summer GEOInternships throughout. For many students at UC Santa Cruz, these programs fulfilled a specific niche as the only initiatives of their kind on campus to offer the academic support and training they needed to continue their intellectual and professional pathways into geosciences.

The GEODES program funded by GEOPATHS originally included four major components:

(1) Drawing on an established and successful academic support program at UCSC (Academic Excellence, or ACE), **GEOAce** was designed as a cohort-based support program, targeting underrepresented minority students, to offer extra academic support in earth and planetary science through course-based problem-solving sessions, skills workshops, peer mentoring and professional development for advisors.

GEOAce problem-solving sessions began the fall of 2019 and continued through the 2020-2021 academic year. Sample GEOAce courses included EART 110A: Evolution of the Earth, Conducting Scientific Research, EART 111: Mathematics in the Earth Sciences, Scientific Writing, and Quantitative Analytical Skills. During the pandemic, GEOACE courses were also offered on Zoom. However, they were discontinued once students returned to campus as after the pandemic students were overwhelmed and there was low interest in enrolling in additional classes beyond what was required. Overall, over 100 students participated in Geo-ACE.

(2) During the summers from 2020-2023, the **GEOInterns** program provided eight-week, full-time paid summer internships to 65 underrepresented minority and first-to-college undergraduate students to expose them to geoscience work options in placements beyond academia including a wide array of federal, state and local agencies, non-profits, education and private sector companies. Interns were given weekly tasks within a "GEOInterns Handbook" to review goal setting, expectations, responsibilities, daily conduct, time management and tips for a successful internship, keeping a reflection journal, etc. In addition, they participated in weekly

meetings to share their experiences, and to hear from guest speakers representing different industries and work sectors and other topics based on students' interests. GEOInterns reflected on their experience through required journaling activity and a final analytical-reflective paper. Students were also encouraged to share their work experience as a poster presentation at the end of their summer internship either on campus or at a scientific conference such as the American Geophysical Union (AGU), Geological Society of America (GSA), or Society for Advancement of Chicanos/Hispanics & Native Americans in Science (SACNAS).

(3) **The GEOSlug Mentors** were graduate students from within the EPS department who were recruited to mentor GEOACE students as well as to other undergraduate students in the department. Starting in Fall of 2019, 15 graduate student mentors met with their individual undergraduate mentees at least once per month to nurture relationships between students, faculty, and staff that were oriented towards personal and academic development, without the pressure of grades. The mentors received initial training through the UCSC Center for Innovations in Teaching and Learning to prepare mentors in establishing a sustainable relationship with their mentee through goal-setting; the ethics of mutual accountability; and exposure to common challenges faced by underrepresented minority undergraduate students in EPS and the ways mentors can intervene to address these challenges. Subsequently, one-hour quarterly trainings tailored to the specific needs of the participating mentors and mentees were planned but they did not happen due to the pandemic and subsequent shift to remote learning. The GEOSlug mentoring program started in-person and switched to Zoom when remote learning began. The program did not operate the following two academic years, and resumed for the 2022-23 academic year as a departmental program through the Center for Innovations in Teaching and Learning, institutionalized at UCSC in part through the GEODES project.

(4) Open to all EPS undergraduate students, the **GeoSlugs Lounge** was designed to foster a geoscience student community and near-peer support system by creating a welcoming space to gather, develop friendships, host professional development events, and receive tutoring and mentoring from graduate students (guided, course-related problem solving as well as general advice and support). It began during the 2019-2020 academic year, but due to the pandemic in spring of 2020 and the move to remote learning, the lounge did not continue while students were off-campus. It reopened in the Fall of 2022 and is used regularly by students for diverse activities (lectures, movie nights, studying, etc.).

In 2019, Dr. Bernadette Chi was contracted to lead the evaluation for the GEOPATHS program, and hired Jenny Han to assist with the evaluation study. Dr. Chi was responsible for the development of instruments, data collection and analyses, and presentation of findings. Dr. Chi has extensive experience in research and evaluation of educational and community-based programs over the last 20 years, including leading evaluation studies of STEM undergraduate and graduate education programs designed to encourage under-represented students to pursue STEM majors and careers. Dr. Chi collaborated with the GEODES project team to coordinate data collection and analyses to minimize the burden on students and staff.

This report summarizes findings from four previous annual evaluation reports to address the following questions:

- To what extent has the program been successful in implementing its goal?
- What have been the program accomplishments and area of improvement?

Methods and Samples

The GEODES/GEOPATHS evaluation utilized a mixed-methods design including surveys with Likert and open-ended questions for all program participants including GEOAce students, GEOAce facilitators, GEOInterns, GEOIntern hosts, and GEOSlugs mentors and mentees. Survey invitations were sent via email and data was collected anonymously through Qualtrics to 87 undergrad students who enrolled in GEOAce courses upon the completion of the fall, winter, and spring quarters and to participating graduate student instructors/facilitators in January and in June of 2020 and 2021. For the GEOSlugs mentoring program, surveys were sent via email to 15 mentors and mentees June of 2020. For 64 GEOInterns, pre-post surveys were sent before and after their summer internships, with post-only surveys administered to 32 internship hosts over the course of the grant period.

Findings and Recommendations

This section summarizes the findings and accomplishments for each of the program GEODES components with recommendations for improvement and expansion for future programming.

A. GEOACE courses: Students and facilitators both reported the high value and benefits of discussion sections/courses that provided additional support to undergraduate students interested in geosciences. Greater coordination with the existing ACE program at UCSC will provide improved support for both students and facilitators to diversify STEM fields of study and industries.

GEOACE courses were inspired by the ACE (Academic Excellence) program at UCSC that has focused on increasing the diversity of students in STEM over the last 30 years. The ACE program supports students through active learning in prerequisite STEM courses, peer mentoring, skill-building, and community development. GEOACE courses are those that are considered foundational courses in geosciences at UCSC; to support students to be successful in these courses would be important for their continued academic journeys in these fields.

UCSC undergraduates reported enrolling in GEOACE courses for a variety of reasons. Most named the desire to better understand class material. Students also expressed motivation to get more involved within the Earth Systems department, treating GEOPATHS as an extracurricular opportunity to get to know more students and faculty, and explore future careers in the geosciences.

I wanted to get more involved in the Earth Science department and...I wanted to make sure I was getting help in my classes and meeting others in the same major as me because I wanted to know people that were also studying what I was studying. (GEOACE student, 2019)

In post-course surveys, over 80% of students rated the helpfulness of the GEOACE program as helpful to extremely helpful in building a cohort of students interested in geosciences; improving their study skills; increasing their confidence to participate in class; improving their learning of class content; and improving their writing skills. Students also cited increased confidence in the content material and an increased sense of support from the department. Students also reported a continued interest in pursuing graduate studies and careers in geosciences. Overall, students were very grateful for the support they received in GEOACE. In particular, the small group setting, opportunity to practice and review content with graduate TAs, and access to other resources within GEOPATHS were much appreciated.

I felt supported by my TA because it was clear they were giving thoughtful advice and they really wanted to make sure we all understood the material and had all our questions asked...My TA emailed me after seeing my poor performance on assessments at the beginning of the course, and they offered to serve me a tutoring session if I wanted one. Of course I took up that offer, and I did so much better on the next assessment. (GEOACE student, 2020)

This attention to the students enrolled in GEOAce courses during the shift to online learning was especially noted with appreciation by the students:

The GEOPATHS sessions were the highlight of the course. They were at times the only thing that kept me from falling too far behind to the point where I would have had to drop out. In online school it's really easy to feel isolated or to wind up isolating yourself and I felt like the GEOPATHS staff did everything they could to keep that from happening to me and my peers. (GEOAce student, 2020)

The GEOAce facilitators reported valuing the opportunity to teach and mentor undergraduate students, and seeing evidence of undergraduates' success in the GEOAce courses from both faculty and students:

I enjoyed connecting with the students beyond the classroom, engaging in a more relaxed learning process, and watching them arrive at realizations and conceptual understandings of the material. I enjoyed engaging as an instructor, mentor, and ally, especially to the underrepresented students. (Facilitator, 2020)

My advisor taught the class that I was a GEOPATHS facilitator for, and I felt like he was fairly supportive of my being a facilitator. He seemed skeptical at first of the program but supportive all the same. And as the quarter went on and the students in GEOPATHS did well in the class he definitely seemed to appreciate the program more. (Facilitator, 2019)

Areas to improve/expand/explore further

Suggestions to improve GEOACE courses included recommendations to better support undergraduate and graduate students in their learning and career pathways through regular trainings and check-ins; to better publicize and support facilitators and students; to clarify facilitator roles and expectations; to coordinate regular check-ins with program staff and faculty while teaching the GEOACE courses to provide facilitators feedback for improvement; and to share lesson plans developed for each course to reduce the workload for future facilitators.

Other recommendations included considering financial compensation to students to incentivize and broaden participation in the GEOACE program; connecting students involved in GEOACE courses with participation in the GEOPATHS internship program to increase student motivation in their GEOACE coursework; and utilizing the GEOACE/GEOPATHS website to promote all program components.

I think GEOPATHS is an excellent idea with much potential. We need to increase GEOPATHS student recruitment and attract more at risk of failing or struggling students. I think much work needs to be done to entice people to sign up. Not only flyers, but also information sessions by faculty within the department (students are already familiar with them), email blasts, and greater departmental support and advertising. We could even have a student academic support fair of sorts where GEOPATHS has a booth and stickers or some kind of swag. If we want to build community, that's a great way of doing it. (Facilitator, 2019)

Evaluation of the GEOACE courses could be improved in the future with shorter surveys and greater integration of post-course survey administration into the final session of each GEOACE course to increase response rates. In addition, since students often enroll in more than one GEOACE course, it is important for both students and facilitators to understand why completing the surveys is important to documenting their experience with each course.

B. GEOInterns highly valued the opportunity to intern with governmental agencies and industry placements, in addition to research labs, to increase their understanding of potential geoscience-related careers, to develop skills, and to expand their networks. Even when students reported unanticipated challenges at their internships, they overwhelmingly (over 95% across the years) recommended the internship experience to other students.

Accomplishments

Most students reported that they would not have been able to participate in the internships without the paid stipend to cover their housing and other costs for the summer. Given the focus on supporting students who are underrepresented in geosciences and who are often first-generation to college and/or come from lower income communities, the stipend eliminates a critical barrier to participation.

I am here for the experience and learning about career prospects, [but] the stipend is very helpful because I have family responsibilities to take care of and times have been challenging since the pandemic occurred. (GEOIntern, 2021)

Over 80% of students also reported having no friends or family members involved in geoscience careers prior to the internship. It is promising, then, that students reported a statistically significant expansion of their professional networks this summer “of people working in the geosciences who you feel comfortable reaching out to with questions or about job opportunities.”

Over 90% of respondents indicated that their internships gave them skills and work experiences to help them in their academic careers and their future employment. This is especially notable given that this internship was the first and only geosciences-related work experience for over half of the cohort. All interns reported gaining a variety of domain-specific and domain-agnostic skills, including research, technical, communication and networking skills. The majority of GEOInterns reported increased interest in the geosciences, their geosciences major, and their commitment to pursue a geosciences career.

I do not have any work experience in the field that I plan to go into after I graduate, so being able to participate and work on projects that I feel passionate about is going to be rewarding. I also believe that this internship will be giving me valuable experiences that will help me find work in the future. (GEOIntern, 2019)

Areas to improve/expand/explore further

Specific recommendations to improve the internship program have remained consistent over the years, including:

- retaining the stipend to ensure that the internships were accessible to all students regardless of their financial background;
- starting recruitment of students (and hosts) as early as possible so that both students and hosts can plan accordingly;
- advertising the program through multiple means though it was suggested that priority for students who enrolled in GEOAce courses may increase motivation to sign up for those courses;
- continuing to expand the number and types of internships available in non-profit, governmental and industry organizations in addition to academic research labs, and in areas such as ecology, fossils, oxygen/carbon isotope geochemistry, long term ecosystem/climate change, geophysics, planetary science, meteorology, and education;
- and continuing to orient and support interns and hosts through Zoom calls and/or in-person events, contracts with interns and hosts, revision of the GEOIntern handbook, speakers to share their educational and career journeys, and weekly intern workshops with topics such as job searches, networking, funding for graduate school and resume building.

Staffing to support interns and hosts through the summer program remains critical, as challenges inevitably arise for some interns/hosts that need to be managed and supported.

C. Most GEOIntern hosts found the experience to be beneficial to their work, even through the pandemic and remote/hybrid internships. They would recommend the GEOIntern program to their colleagues, especially given the stipend to support UCSC students underrepresented in the geosciences including students of color and undocumented and/or first-generation to college students from lower income backgrounds.

Accomplishments

Over the course of the grant period, 32 organizations hosted a GEOPATHS intern some of these organizations hosted an intern for multiple summers. There was a range of experiences with the GEOInterns, but most were positive.

(The intern) was great to work with. She was punctual, curious, and willing to help on any type of project. (GEOIntern host, 2019)

I knew this would be a difficult year for your mentoring and it was. That said it went better than I expected in that we were able to set up some reasonable communication expectations and (the intern) did a great job in following them. She made very good use of our somewhat limited time by being well prepared and coordinated. (GEOIntern host, 2019)

Over the grant period, more than three-quarters of the hosts reported that their experience as host of a GEOPATHS intern met their goals and expectations. After the internships were completed, the majority of hosts reported having already or planning to disseminate results from the interns' work at conference presentations, research papers and university seminars. Blogs were the least likely place the hosts planned to disseminate findings, followed by social media, presentations to the public and official reports. One host suggested that with additional guidance, they would be interested in sharing the results and findings of interns' work more broadly.

Areas to improve/expand/explore further

The host organizations for the GEOIntern program offered a variety of suggestions for improvement including more detailed description of the goals of the program with detailed expectations of interns and hosts; reporting requirements; meeting the students prior to the start of the internship; scheduling of hours; criteria for the interns' final product with potential dissemination strategies. Some hosts also requested to have a say in the selection of their interns. In addition, the evaluation team recommends that the program continue to refine the orientation and training process for interns and hosts through online calls and written guidelines/expectations, and continue to expand the number and type of internship experiences in non-profit, governmental and industry settings. As noted earlier, staffing to support interns

and hosts through the summer program remains critical, as challenges inevitably arise for some interns/hosts that need to be managed and supported.

D. The GEOSlug mentoring program connected 15 graduate student mentors and undergraduate mentees in the Earth and Planetary Sciences Department that offered students underrepresented in the geosciences opportunities to learn from more experienced students about their academic and professional pathways.

Accomplishments

Undergraduate mentees primarily applied to the mentorship program for a chance to develop professional skills and explore post-undergraduate options, which were either to secure a job or attend graduate school. Graduate students voiced their interest in connecting with the Earth Sciences undergrad community, and in gaining formal training as a mentor and practicing mentorship skills. They expressed a desire to “pay it forward” in terms of past mentoring and support they had received:

I believe in good mentorships and strong community support, especially for underrepresented students...Good mentorship got me where I am, now it's my turn to start doing that. (GEOSlug Mentor, 2020)

The one-on-one pairing encouraged mentees to ask questions of more experienced students who would listen to them and offer support as they explored academic and career pathways in geosciences:

I have really benefited from the one-on-one guidance from a current grad student. I hope this becomes a permanent part of the program and department because I think it is really helpful especially for first-generation college students to get help with picking concentrations, etc. (GEOAce Mentee, 2019)

Areas to improve/expand/explore further

The GEOAce mentoring program was able to operate for almost a year before the start of the pandemic and move to online learning. There was an attempt to move the program online once students left campus, but both mentors and mentees found it challenging to maintain the relationships online. Specific recommendations for this program mentors and mentees are described in more detail in the GEODES/GEOPATHS Year 1 (2020) report. In summary, both mentors and mentees suggested that there be more structure and guidance to mentors and mentees through group-wide programming including orientation and ongoing training for mentors/mentees, timeline of benchmarks for what mentors/mentees were expected to cover over the year, social/professional events, workshops/discussion topics, speakers, and documentation of lessons/resources that the PI and mentors could share with each other.

In previous mentoring programs I've participated in, we had monthly dinners with some sort of professional development programming. This allowed mentees to

interact with each other and other mentors, which helped them rate how interactions with their own mentors were going. If they wanted more or less, they could gauge what other types of mentor/mentee relationships are available. It's understandable that COVID-19 has interrupted any potential plans, but we could have done virtual meetings. (GEOAce Mentor, 2020)

In addition, students and mentors suggested that it would be highly desirable for mentors and mentees to have shared interests in terms of academic disciplines and future graduate school and/or career goals, if possible.

E. The GEOSlug Lounge operated for a much shorter period than planned due to the pandemic and shift to online learning but offered a quiet, dedicated learning space to support geoscience students while they were on campus.

In the 2019-2020 academic year, GEOPATHS launched a dedicated space and time for students to study through the GEOSlug Lounge. Because students left campus mid-year due to the pandemic, they were not specifically asked about the lounge in the evaluation process later that year. In the Year 1 report, one student did report appreciating the "quiet and neat learning space" (GEOACE student, Fall 2019) that GEOPATHS provided. Other students shared that the learning space could be improved with a projector, another surface for writing (such as a chalkboard or whiteboard) if possible.

Conclusion and Next Steps

Despite the significant challenges of COVID and the move to remote learning during the grant period, much of the GEODES program was successfully implemented to support students in the UC Santa Cruz Earth and Planetary Sciences department, including the program mentors and GEOSlug Lounge during the first year of the grant prior to remote learning and the GEOAce courses and summer GEOInternships throughout. For many students at UC Santa Cruz, these programs fulfilled a specific niche as the only initiatives of their kind on campus to offer the academic support and training they needed to continue their intellectual and professional pathways into geosciences.

For example, GEOACE was able to provide personalized support for foundational geoscience courses that were already challenging as a result of shifts to remote learning and back. The GEOInterns summer program was a critical access point for work opportunities for students with limited previous experience, even during the pandemic with online, hybrid and in-person internships.

A common theme throughout the evaluation data was the call for an expansion of GEODES offerings, including more GEOACE courses in additional geoscience subdisciplines; more GeoIntern placements across industry, non-profit and governmental agencies; and more access to mentoring opportunities for undergraduate students to learn about graduate school and career exploration. These are promising indicators of the need for GEODES program

components in the future, especially to serve more low-income, undocumented and/or first-generation college students including transfer students. For example, in an effort to capture additional demographic data, we learned that 30% of GEOIntern participants were first-generation college students and 80% of GEOIntern participants did not have friends or family who worked in the geosciences, reinforcing the need for programs such as GEOInterns and GEOACE to broaden participation in the geosciences.

A common area for growth that emerged from the data across program components was in *pre*-program planning, which includes the communication, training, and events leading up to the first day of the programs. Interns, hosts, facilitators alike requested more communication and transparency in expectations, training, and schedules before the programs officially began. In addition, survey data across respondents noted three ongoing areas of improvement: (1) the challenge of providing quality training and professional development, (2) the challenge of building community within cohorts, and (3) the challenge of reaching students who are most in need of these resources.

Pre-program planning and communication would also help the evaluation team collect more complete data from participants across program components. A centralized schedule would be crucial for participants, program staff, and evaluation team to better understand when program activities are starting and finishing, including ways to track students who participate in multiple components of the program to minimize their data burden in completing surveys.

As work in the earth and planetary sciences becomes increasingly important in addressing critical global issues, GEODES/GEOPaths continues to offer valued STEM learning opportunities and networks within and outside of UC Santa Cruz to support under-represented and first generation to college students interested in the geosciences.